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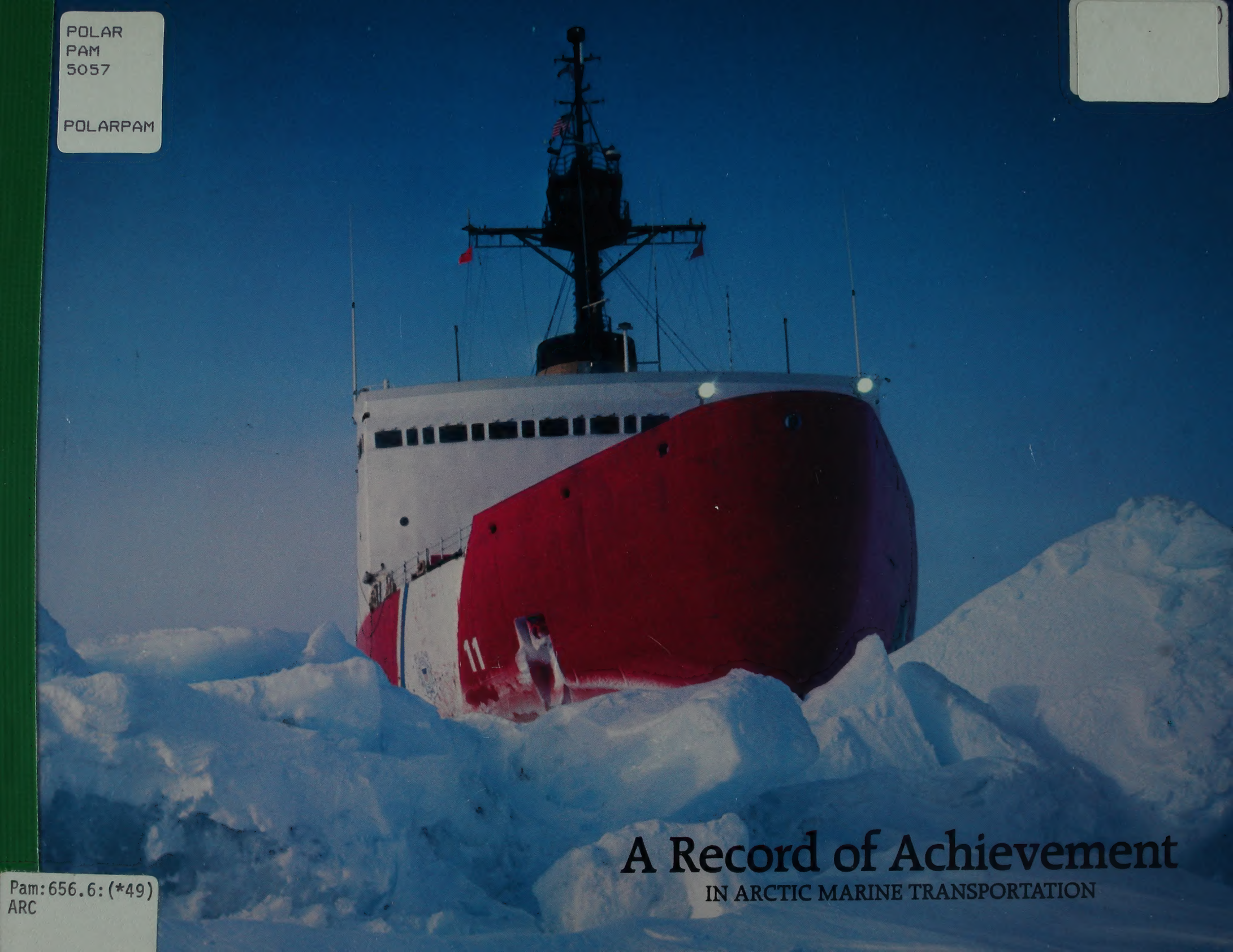

A Record of Achievement

IN ARCTIC MARINE TRANSPORTATION

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Sea Ice Cover in the Northern Hemisphere

Historically, the national policy of the United States concerning the Arctic has focused on a number of key objectives. Among them are:

- support for resource and energy development while preserving the environment;
- promotion of scientific research to increase the body of knowledge on the Arctic environment;
- maintenance of essential national security;
- advancement of mutually beneficial international cooperation.

This booklet gives an overview of a multiyear program to assess the feasibility of year-round marine transportation in the ice-covered waters of Arctic Alaska in support of the above objectives.

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The National Need

Large quantities of oil, gas, and hard mineral resources are known to exist in the Arctic. Recent federal and private studies indicate that, of all the regions of the world, this area has the greatest potential for new oil and gas discoveries.

The U.S. Arctic is projected to contain 20% of the global Arctic resources, and could contribute as much as 50% of our nation's future oil and gas. Of further interest is the fact that 65% of the oil and 78% of the gas potential is projected to lie in offshore areas which are seasonally ice covered. President Ronald Reagan, recognizing the importance of Alaskan Arctic oil and gas potential, has initiated an active lease sale program in this area.

Five-Year Offshore Lease Sale Schedule

AREA	YEAR OF LEASE SALE				
	1983	1984	1985	1986	1987
Diapir Field (Beaufort)		☐		☐	
Barrow Arch (Chukchi)			☐		☐
Norton Basin	☐		☐		
Navarin Basin		☐		☐	
St. Georges Basin	☐	☐		☐	
N. Aleutian Shelf			☐		

Locating open water leads between ice floes results in highly successful ship transits.

Development of these resources in a timely and economical manner is an integral part of our national energy policy. However, one of the greatest impediments to their development is the lack of a transportation system which can move these energy resources to the continental United States.

Pipeline systems, which have often been considered the most promising method of moving Arctic oil and gas in the past, may no longer be affordable. The Trans-Alaskan Pipeline System cost approximately $9 billion to build in 1970; estimates for an Alaskan gas pipeline built today reach $40 billion.

Marine transportation has traditionally been associated with high risks and uncertainties due to the fact that ice-breaking ships have never operated in most of Alaska's ice-covered waters during the winter season. However, if these risks could be reduced, marine transportation could represent a cost-effective alternative for the transport of Alaskan energy resources.

As research on Arctic marine transportation continues, the results of studies on environmental protection and the needs of native people must be carefully considered. In this way, our national objectives can be met in a timely and orderly manner.

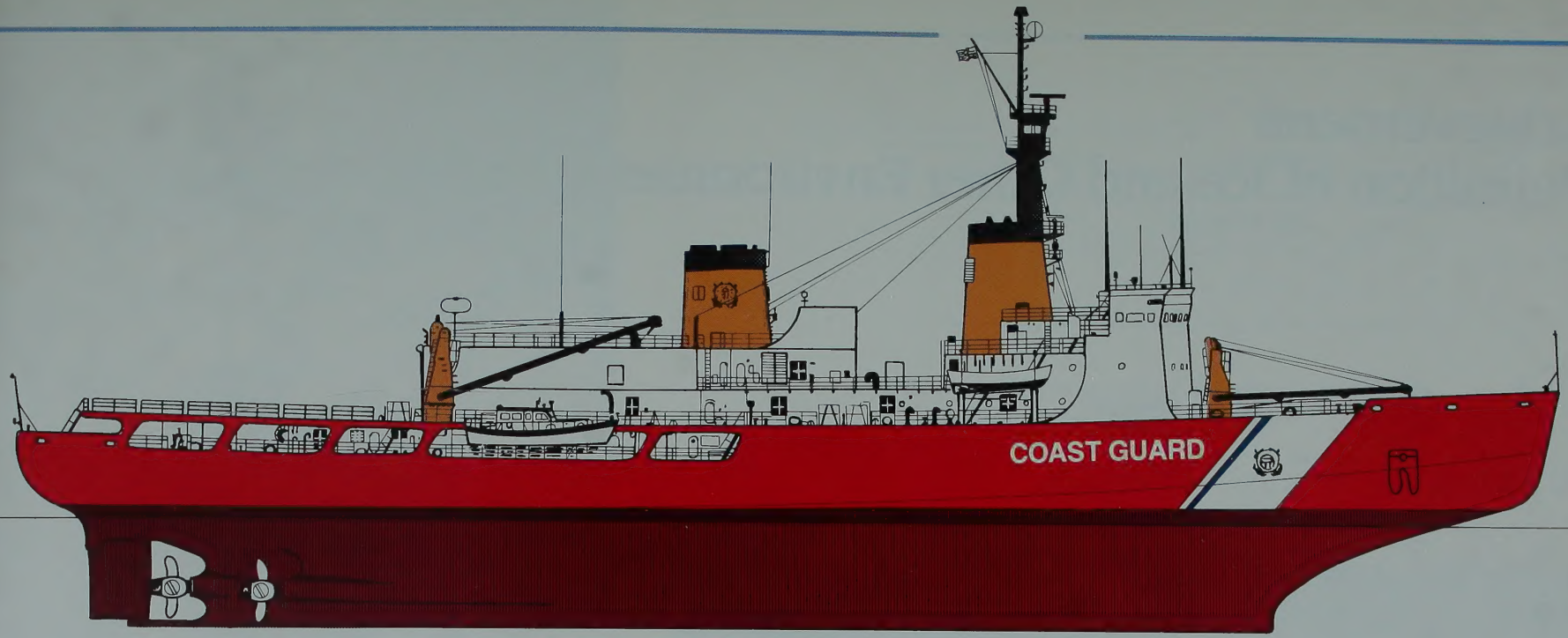
The Arctic Marine Transportation Program

In order to determine if risks and uncertainties associated with marine transportation in the Arctic could be eliminated or reduced, the U.S. Maritime Administration initiated a multiyear research program to:

- define the environmental conditions in the Bering, Chukchi, and Beaufort Seas;
- obtain data to improve design criteria for ice-worthy ships and offshore structures;
- demonstrate the operational feasibility of commercial icebreaking ships along possible future Arctic marine routes.

This research was performed using our nation's two U.S. Coast Guard POLAR Class icebreakers—the *POLAR STAR* and *POLAR SEA*. These ships are the world's most powerful non-nuclear icebreakers, and the only U.S. ships capable of mid-winter Arctic operations.

Program achievements during the six-year period from 1979 to 1984 are shown on the following pages. These achievements were made possible by joint industry-government cooperation. Their sponsorship and interest in cost-sharing these activities have made this multiyear program most successful.



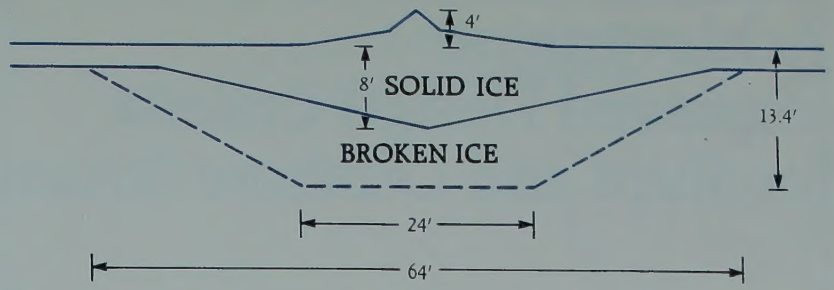
Principal Characteristics of U.S.C.G. POLAR Class Icebreakers

LENGTH OVERALL	399 FEET
LENGTH AT WATERLINE	352 FEET
BEAM	83.5 FEET
DRAFT	31.8 FEET
DISPLACEMENT, CAPACITY LOAD	13,190 TONS
RANGE (MAXIMUM)	28,274 MILES
SUSTAINED SPEED (OPEN WATER)	17 KNOTS
PROPULSION	DIESEL ELECTRIC OR GAS TURBINE
SHP	18,000 DE 60,000 GT
NUMBER OF PROPELLERS	3
COMPLEMENT	14 OFFICERS 126 ENLISTED
SCIENTIST ACCOMMODATIONS	20
HELICOPTERS	2

Achievement:
Definition of Ice and Other Environmental Conditions

PRIOR KNOWLEDGE	PROGRAM RESULTS
● Very limited data on summer multiyear ice properties.	● 16 summer multiyear floes and ridges profiled. ● 18 ice cores taken.
● No pressure ridge profiles of multiyear or first-year ice.	● 25 multiyear and 6 first-year ridges profiled. ● 49 ice cores taken.
● No pressure ridges profiled. ● No rafted ice profiled.	● 78 first-year ridges and rafted ice features profiled. ● 77 ice cores taken and crystallography studies performed. ● Ice drift velocity recorded. ● Representative ridge model developed for the South Bering Sea. ● Ice-edge characteristics defined.

An ice core is taken next to a pressure ridge for later analysis aboard ship to determine ice strength.

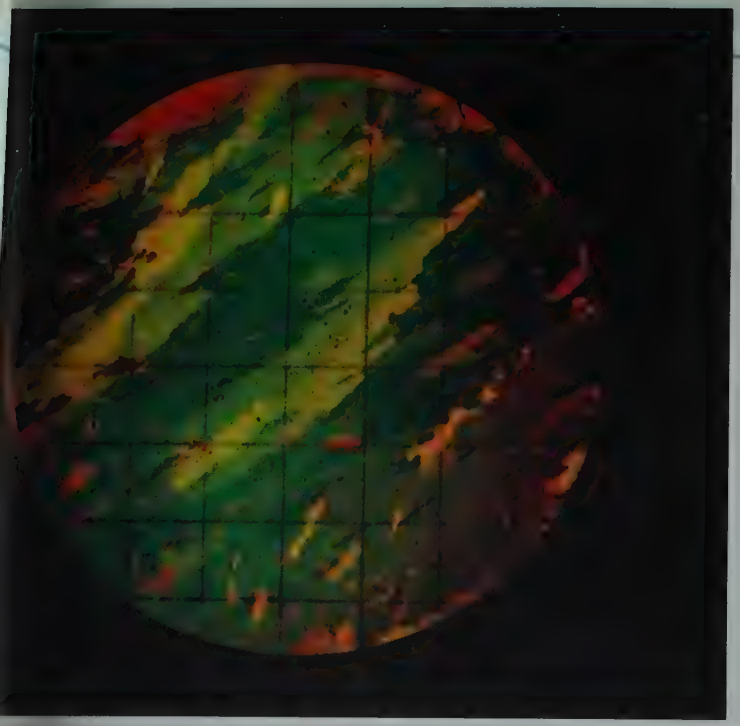


Pressure ridges vary in shape and size. An average ridge in the South Bering Sea is shown above.

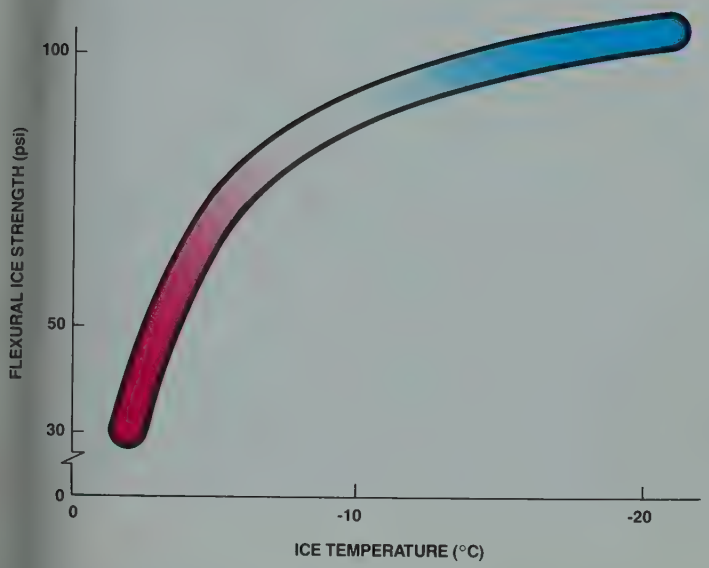
Members of the project team survey ice conditions in the Beaufort Sea.

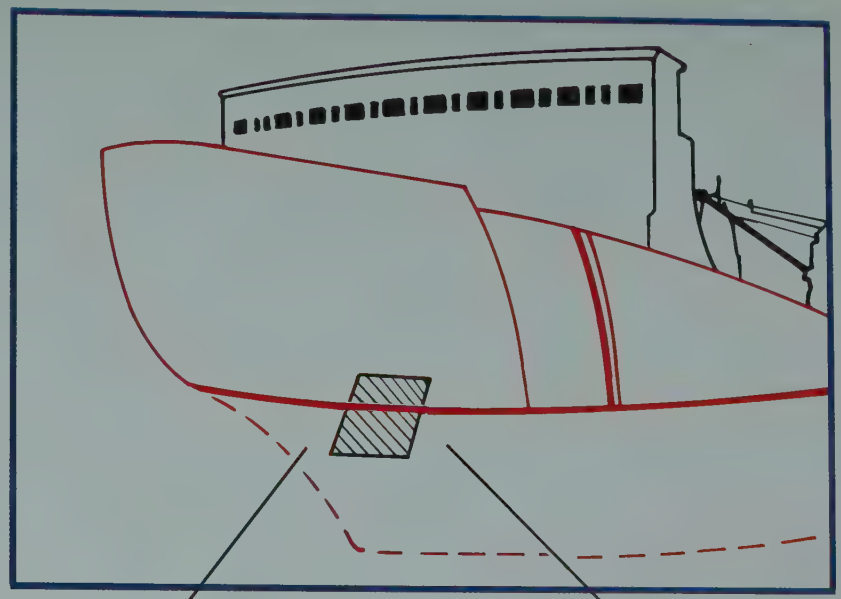
Achievement: Improved Design Criteria for Ships and Offshore Structures

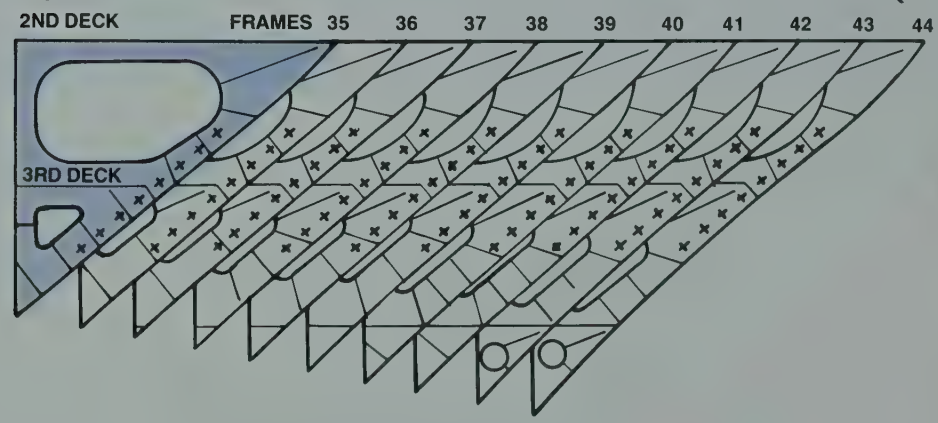
PRIOR KNOWLEDGE	PROGRAM RESULTS
● No data on hull structure ice loads for powerful icebreakers.	● 1,400 sets of data collected on multiyear and first-year ice impacts on hull structure.
● Limited data on structural vibration for powerful icebreakers.	● Vibratory response of ship measured during icebreaking, and analytic model of excitation forces developed.
● No data on steering gear for powerful icebreakers.	● Ice loads on steering gear system measured.
● No field data on experimental low-friction hull coating.	● Low-friction hull coating proved effective in reducing icebreaking resistance and is recommended for all future ice-transiting ships.
	● New analytic models developed to predict performance of commercial ice-transiting ships in level ice and pressure ridges.



● *Temperature, as well as crystal structure, influence the strength of ice.*

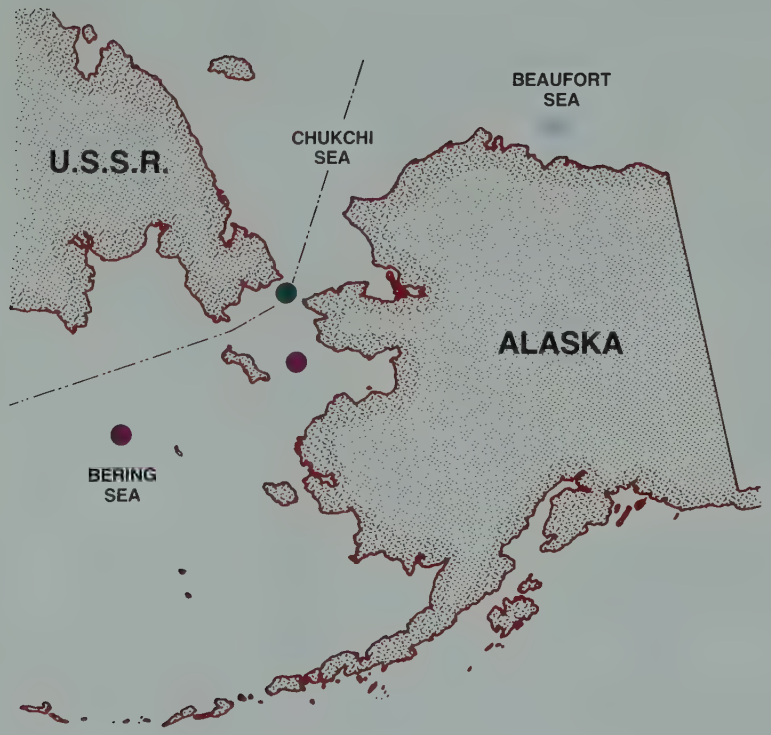






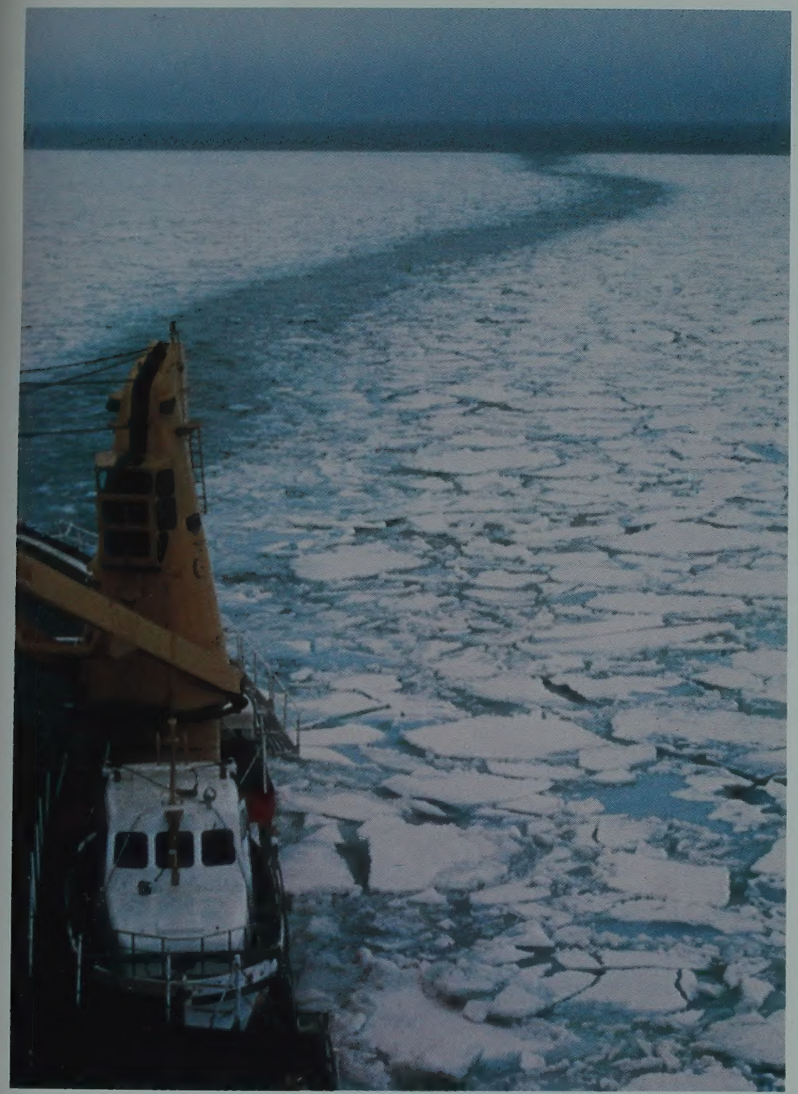
● *Instrumented bow panel aboard* POLAR SEA *records pressures imposed by ice impacting the hull.*

Achievement: Demonstration of the Operational Feasibility of Year-Round Marine Transportation



PRIOR KNOWLEDGE	PROGRAM RESULTS
Marine activity limited to three summer months at Pt. Barrow.	First marine winter transit to Pt. Barrow achieved in 1981; second winter transit to Wainwright in 1983.
Winter transit through Bering Strait deemed infeasible by some experts.	All four winter transits through Bering Strait successful and uneventful.
High risk and uncertainty associated with year-round marine transportation in Bering Sea.	Year-round marine transportation proved feasible in Bering Sea. Ice conditions along typical marine routes established. Little or no icebreaking documented during ship transits in 80% ice concentration. Real-time satellite ice imagery received aboard for the first time (1983) to aid ship routing.

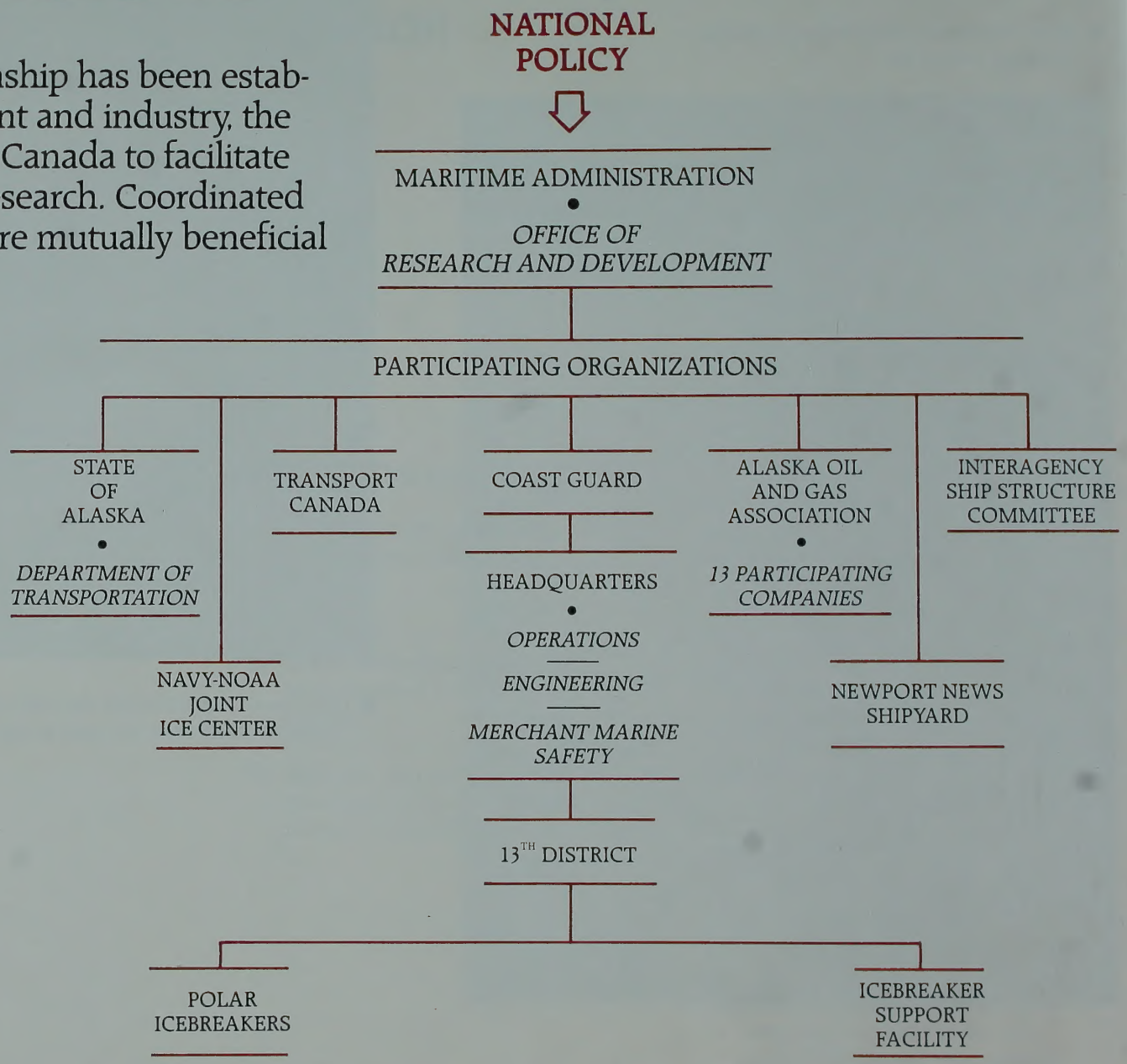
● *Ships travel in a variety of ice conditions, including broken ice.*



● *Good speed is achieved by the ship's ability to maneuver away from the more severe ice conditions.*

Cooperation

A close and continuing relationship has been established between U.S. government and industry, the State of Alaska, and Transport Canada to facilitate Arctic marine transportation research. Coordinated research efforts such as these are mutually beneficial and cost-efficient.



Beyond the Horizon

Arctic marine transportation has been identified as an important factor in addressing our national objectives. The National Academy of Science, Maritime Transportation Research Board, has suggested that immediate development of Arctic marine transportation is a prudent course of action.

Although significant achievements have been realized to date to support our national objectives, a need exists to continue the data collection effort, particularly in the more northerly regions. POLAR Class icebreakers offer the best opportunity to gather this data as they are the only U.S. vessels capable of transiting through these winter ice conditions.

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This brochure was developed by
ARCTEC, Incorporated
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many sponsors of the data collection effort aboard our nation's icebreakers.
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